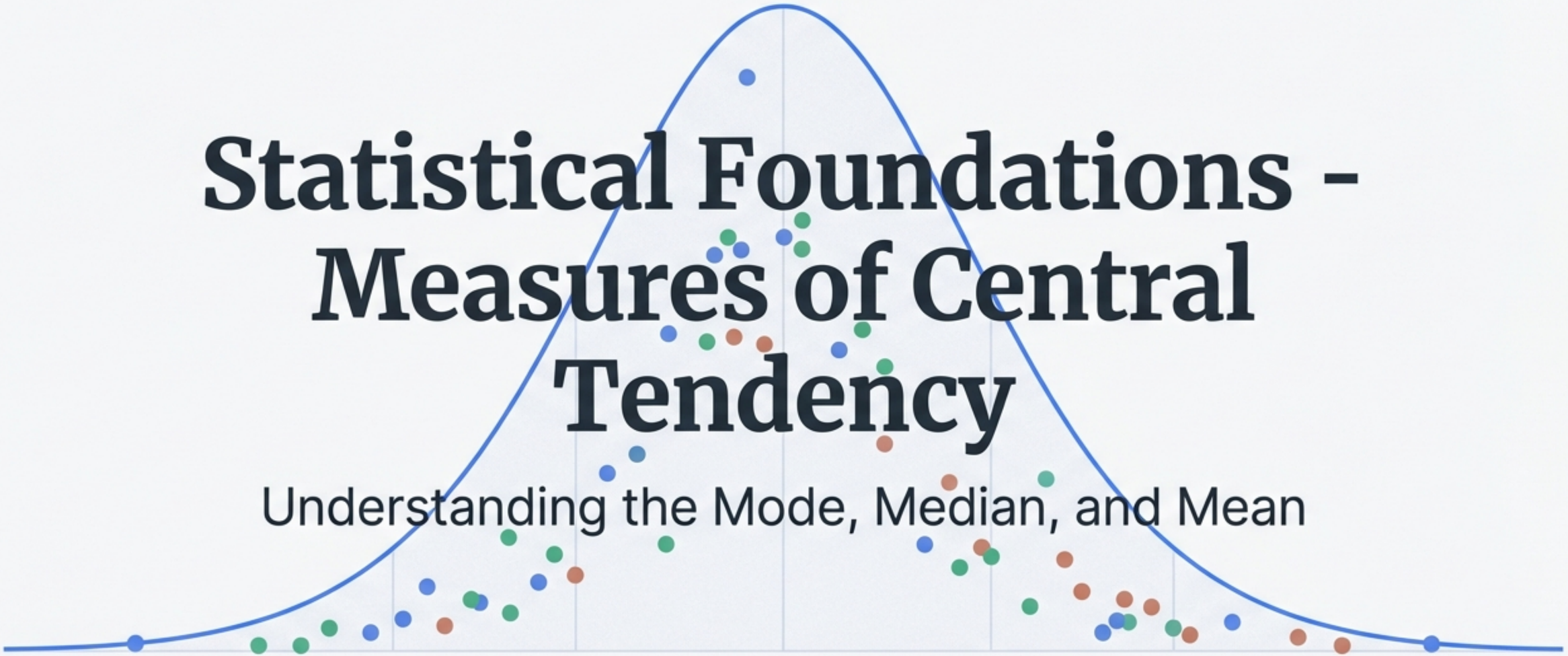

Statistical Foundations - Measures of Central Tendency

Understanding the Mode, Median, and Mean

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Central Tendency – Introduction & Purpose

Definition: Values describing the central, middle, or "typical" characteristics of a dataset.

Relative Value

Understand scores beyond the top rankings. How do non-medalists compare to the group?

Trend Discovery

Identify performance trends over time and compare modern vs. historical data.

Interpretation

Interpret a single score by comparing it to the mean, median, or mode of the group.

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The Mode – Definition, Calculation & Variations

Definition: The score that occurs most frequently in a dataset.

Calculation: Found by ‘Inspection’. Scan the list or frequency distribution. No complex formula required.

Variations:
Bi-modal: Two scores share the highest frequency.
Multimodal: More than two scores share the highest frequency.

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The Mode – Advantages & Disadvantages

Pros

- Easiest to determine (Quick estimate).
- Fair description of central tendency for normal distributions.

Cons

- **Unstable**: Changes based on grouping methods.
- **Terminal Statistic**: No use for further calculations.
- **Ignores Data**: Disregards value and distance of extreme scores.

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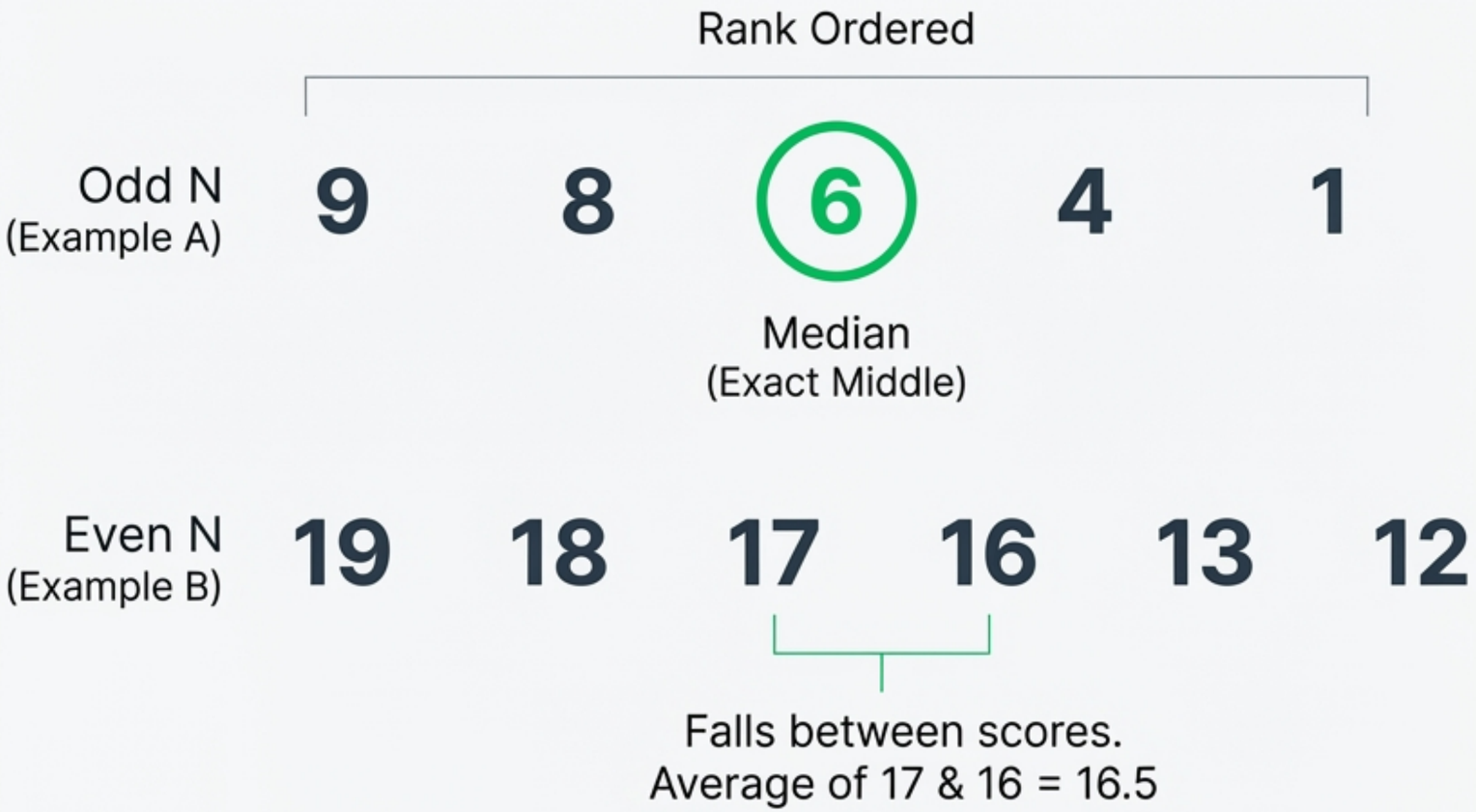
The Median – Undar Definition & Calculation

The score associated with the 50th percentile. Divides the dataset exactly in half.



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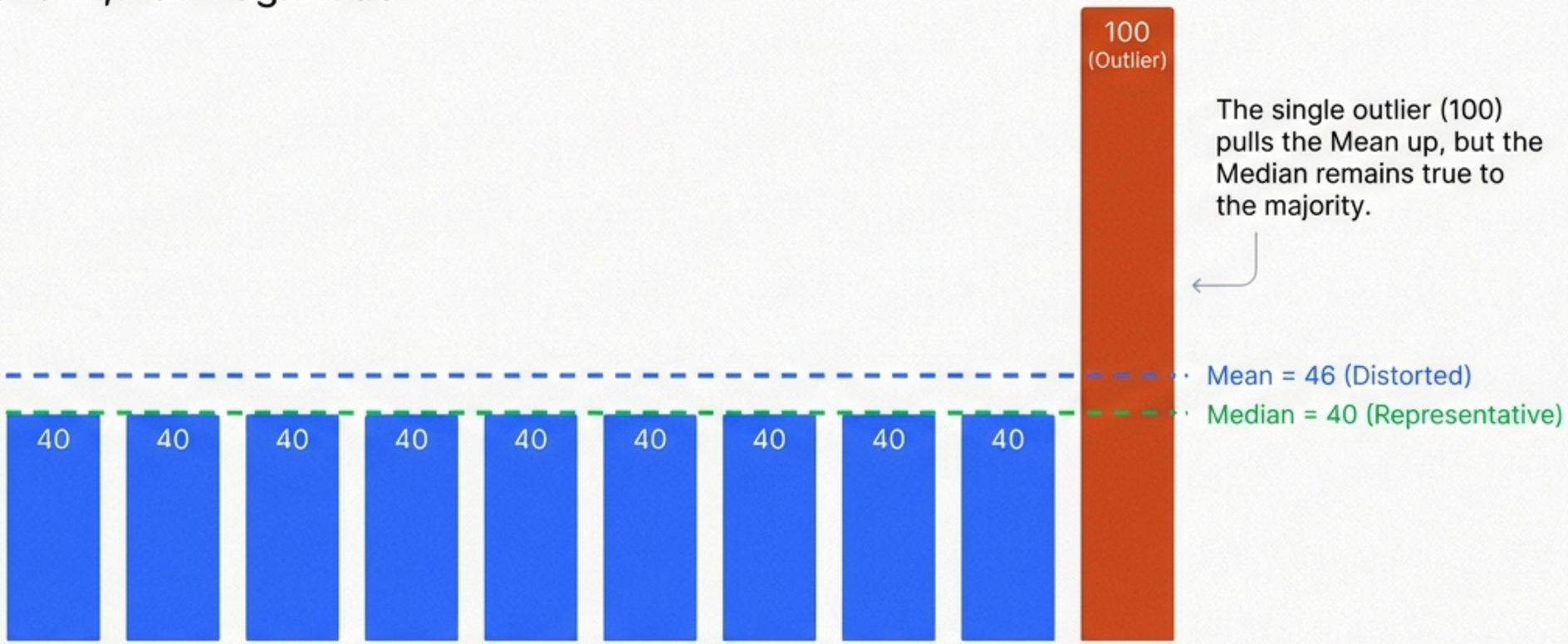
The Median – Characteristics & Evaluation

The ‘Typical Score’. Insensitive to outliers because it considers rank, not magnitude.



Sit-up Example

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The Mean – Definition, Characteristics & Notation

Definition: The arithmetic average; a point on a continuous scale.

Sensitivity: The most sensitive measure. Changing ANY score changes the Mean.

Precision Rule: Report one decimal place beyond the raw data's precision.

Sigma: The sum of

X-bar: The mean of variable X

Variable: X

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The Mean – Calculation Method

$$\bar{X} = \frac{\sum X}{N}$$

(Sum of all scores) / (Number of scores)

Methodology: Hand calculation is good for learning logic, but computers are essential for speed and accuracy with large N.

Sample 200-meter Run Times
X (sec)
33.9
31.2
29.6
27.0
24.7
25.0
23.0
$\sum X$ = 194.4

$\bar{X}$ = 194.4 / 7 = 27.77

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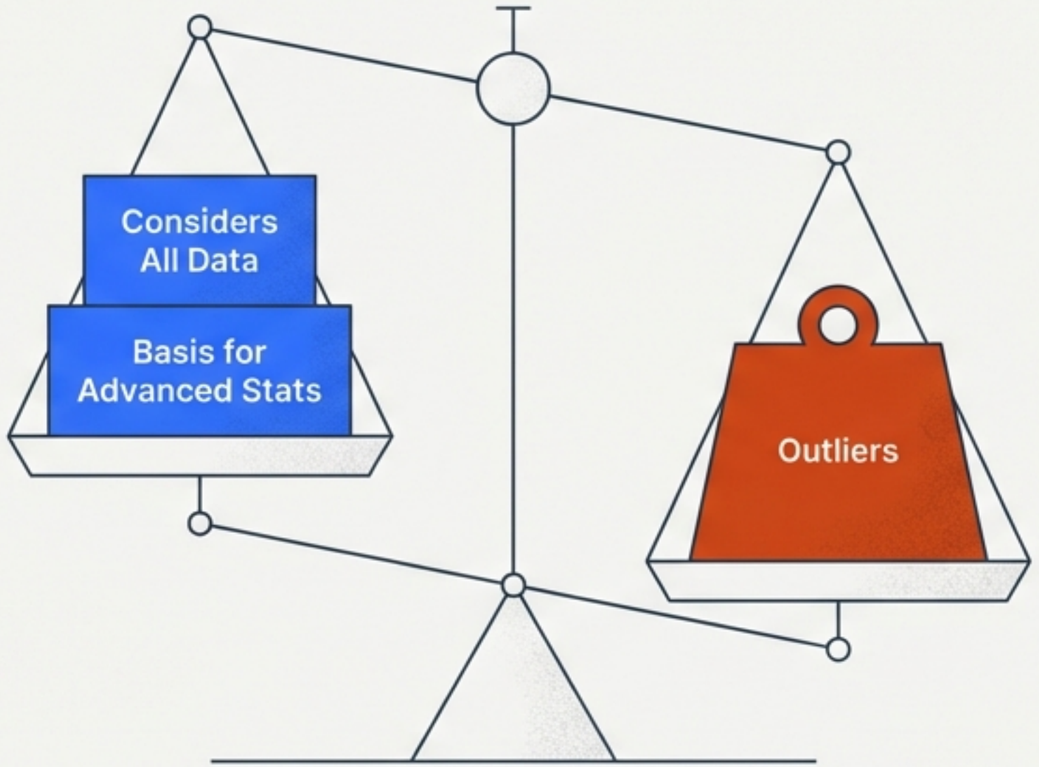
The Mean – Advantages & Disadvantages

Pros:

- Uses all information (value & order).

- Required for Standard Deviation / Z-scores.

- Best for Interval/Ratio data.



Cons:

- Pulled by outliers (Skew sensitivity).

- Inappropriate for Ordinal data.

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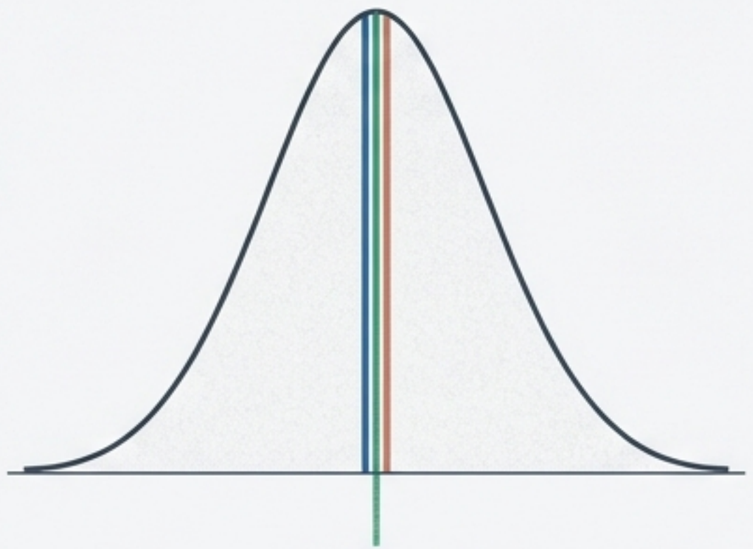
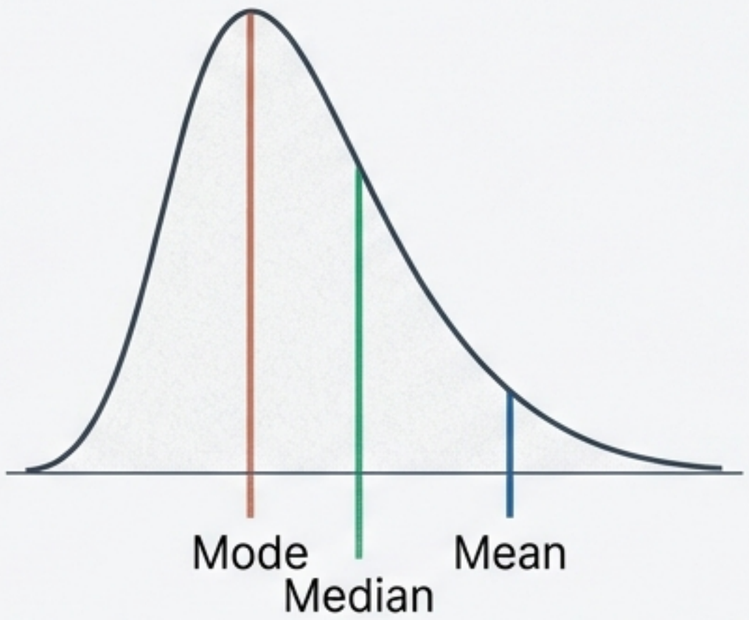
Relationships – Normal vs. Skewed Distributions

Normal Distribution



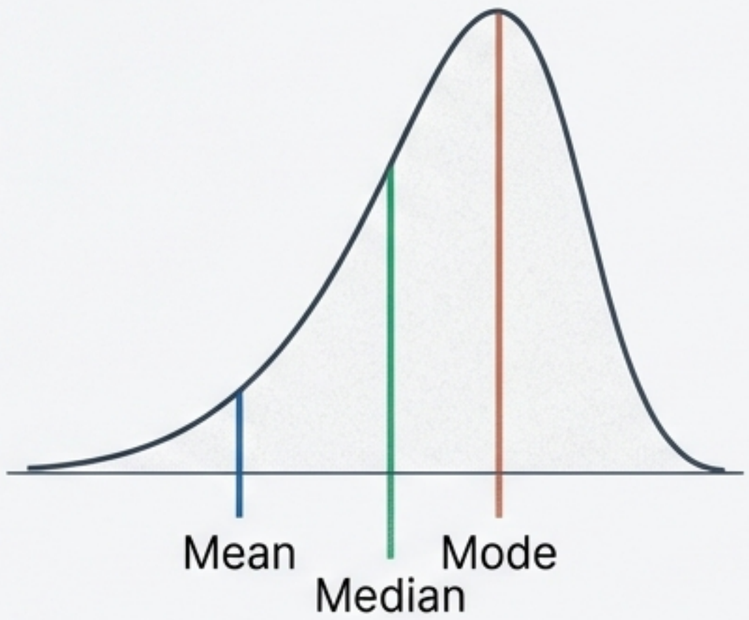
Mean = Median = Mode

Positively Skewed



Mode < Median < Mean

Negatively Skewed



Mean < Median < Mode

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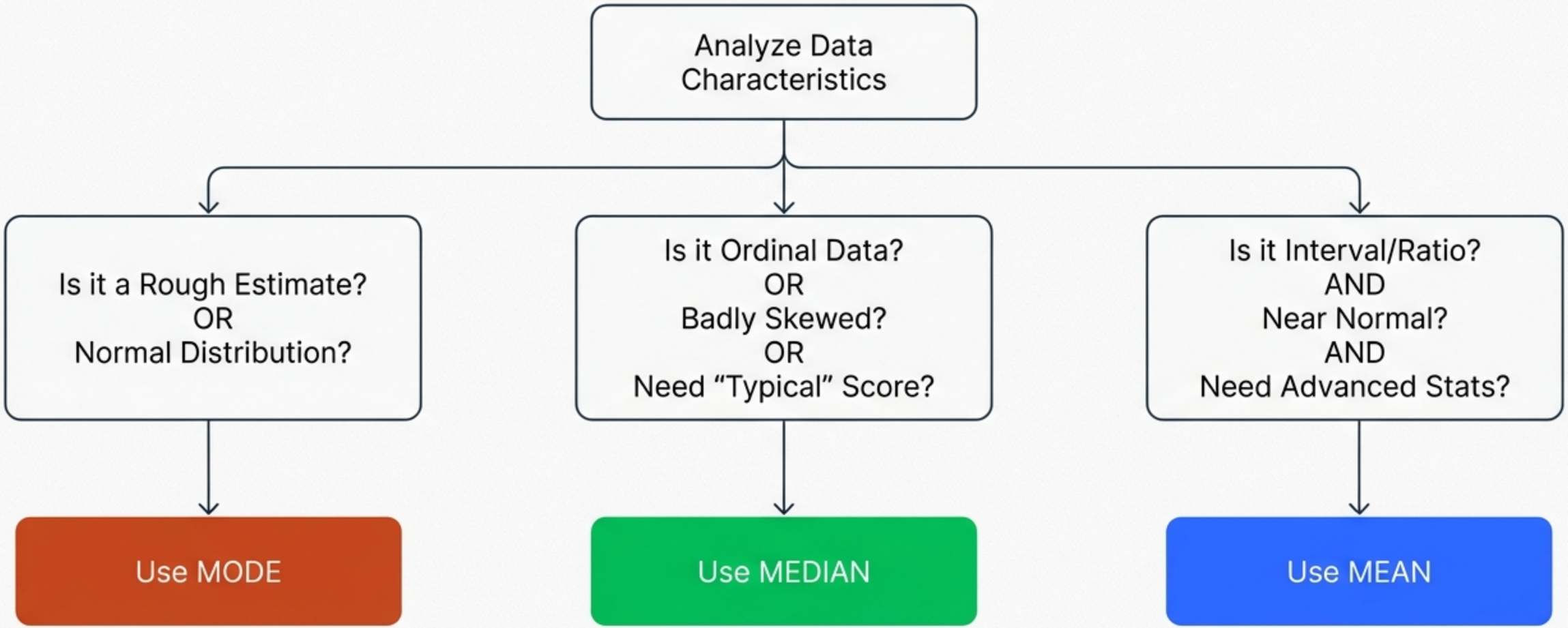
Criteria for Selecting a Measure – The Decision Matrix


Analyze Data Characteristics
Is it a Rough Estimate? OR Normal Distribution?
Is it Ordinal Data? OR Badly Skewed? OR Need “Typical” Score?
Is it Interval/Ratio? AND Near Normal? AND Need Advanced Stats?
Use MODE
Use MEDIAN
Use MEAN

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Logarithmic Transformations – Context & Process

Context: Skewed data (common in Kinesiology) invalidates standard mean calculations.
Solution: Apply a mathematical operation (log_{10} or ln) to normalize the distribution.

Base 10 Log (log_{10})

Natural Log (ln, base e)

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The Geometric Mean – Calculation & Meaning

Two methods to find the center of log-transformed data.

The Antilog Method

1. Calculate arithmetic mean of log scores.
2. Take Antilog to return to original units.

Example: Antilog of 1.440 = 27.5

Data	log X	log Y	log X
1	1.440	1.542	1.030
2	1.420	1.623	1.026
3	1.440	1.664	1.041
4	1.387	1.385	1.634

The Root Method

The nth root of the product of n scores.

$$\sqrt[n]{\prod X}$$

Requires computer calculation due to massive numbers.

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Summary – Key Takeaways

Measure	Primary characteristic	Skew Sensitivity	Best Use Case
Mode	Most Common	Unstable / Terminal	Rough estimates, Normal data
Median	Typical Score (50th %)	Insensitive (Robust)	Ordinal data, Outliers
Mean	Arithmetic Average	Sensitive (Pulled by outliers)	Interval/Ratio, Advanced Stats
Geometric Mean	Log-transformed Average	Normalizes Skew	Log-normal distributions

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